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THE ENVIRONMENT OF VENUS:
A DISCUSSION OF ITS ATMOSPHERE AND SURFACE

By Robert B. Owen, C. L. Hasseltine, William T. Roberts,
George S. West, and Jeanette A. Scissum

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ABSTRACT

Presented is a self-consistent model atmosphere for the planet Venus, with emphasis on parameters of general use in developing vehicle design criteria. Kern and Schilling's program [1] for generation of atmospheric parameter values is coupled with the most recent estimates of surface conditions in order to derive the atmospheric environment at different altitudes. A range of initial values is used to produce a parametric band most representative of actual conditions. Because of the extreme pressures and temperatures involved, it is felt that design for such an environment presents an engineering problem of the first magnitude.

(This document supersedes NASA TM X-53327, "Derivation of Parametric Values for a Greenhouse Model of the Cytherean Atmosphere," dated September 7, 1965.)

NASA - GEORGE C. MARSHALL SPACE FLIGHT CENTER

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LIST OF SYMBOLS

<u>Symbol</u>	<u>Definition</u>
g	effective gravitational acceleration
h	gravitational potential height
H	geometric pressure scale height
H'	potential pressure scale height
H_ρ	geometric density scale height
H'_ρ	potential density scale height
k	Boltzmann's constant
L	lapse rate
m	mean molecular mass
M	columnar mass of atmosphere
n	approximate number density
p	atmospheric pressure
r	radius vector
R	universal gas constant
t	true kinetic temperature
T	molecular-scale temperature
z	geometric altitude
ρ	atmospheric mass density
σ	zero energy collision diameter
N	Avogadro's number
d	mean free path
s	speed of sound
c_p	specific heat

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THE ENVIRONMENT OF VENUS: A DISCUSSION OF
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SUMMARY

A self-consistent model atmosphere for the planet Venus is presented, with emphasis on parameters which are felt to be of general use in development of vehicle design criteria. The most recent estimates of surface conditions are used as initial input, and use is made of Kern and Schilling's program [1] for generation of atmospheric parameter values. A range of initial input is used to produce a parametric band which would be most representative of actual conditions. Because of the extreme pressures and temperatures involved, it is felt that design for such an environment presents an engineering problem of the first magnitude.

I. INTRODUCTION

Because of the general lack of knowledge about the atmosphere of Venus, there have been few self-consistent model atmospheres appearing in the literature. This model is presented to aid in the formation of useful vehicle design criteria. A greenhouse model is used to derive initial values, which are then used to generate atmospheric parameters. Output found to be useful includes atmospheric pressure, molecular-scale temperature, geometric altitude, gravitational acceleration, atmospheric density, potential pressure scale height, columnar mass, approximate number density, geometric pressure scale height, geometric density scale height, potential density scale height, mean free path, and speed of sound.

II. PROGRAM DESCRIPTION

A. General Method

The computer program used in the construction of a Model Atmosphere of Venus is a modification of Version A of Kern and Schilling's "Modat: A Computer Program for the Construction of Model Atmospheres" [1]. It performs a numerical integration of the hydrostatic equation by

providing a step-wise evaluation of the system of equations defining an ideal gas atmosphere. The subscripts "j" and "m" denote the intervals over which the gradients are constant with "j" defining the interval of temperature gradient and "m" defining the interval of molecular mass gradient. The subscript "i" indicates subintervals of evaluation in the "j" and "m" intervals.

The program consists of seven sections - a control routine and six subroutines. The control routine reads in values for the following: (1) the number of values the temperature gradient will take, (2) the number of values the molecular mass gradient will take, (3) initial values for the geometric altitude and its increment size, molecular-scale temperature, molecular mass, atmospheric pressure and gravitational acceleration, (4) the Boltzmann constant and universal gas constant, (5) effective planetary radius, (6) terminal value of geometric altitude, and (7) temperature and molecular mass lapse rate. The control routine also sets up the initial conditions, calls the subroutines, tests the conditions for changing the increment size of geometric altitude, tests the value of geometric altitude for conditions of changing lapse rates, and tests for conditions of terminating the program. The program terminates whenever the temperature is less than 10°K or when the terminal altitude has been reached.

Subroutine Head prints out the input constants, initial conditions and the headings for the output.

Subroutine Xmass contains the conditions and equations for defining molecular mass and C, which is defined as molecular mass divided by the gas constant.

Subroutine Press contains the conditions and equations for defining pressure.

Subroutine Define evaluates the remainder of the system of defining equations.

Subroutine Output prints the evaluated variables for each value of the independent variable, geometric altitude. The output consists of the following: geometric altitude, Z(I); pressure, P(I); temperature, T(I); density, RHO(I); potential pressure scale height, HPRIME(I); columnar mass, CM(I); potential height, SH(I); effective gravitational acceleration, G(I); the geometric altitude at which temperature gradient changes, HEIGHT(I); temperature lapse rate, TL(I); molecular mass, XM(I); geometric altitude at which molecular mass changes, SHMASS(H); mass lapse rate, XML(M); number density, XN(I); geometric density scale height, HRHO(I); and geometric pressure scale height, H(I).

The listing of the program, if desired, can be obtained from Mrs. J. A. Scissum, R-AERO-Y, MSFC.

B. Mathematical Basis

In an actual planetary atmosphere, available empirical data must be taken into account for derivation of parameter values. This is done by permitting substitution of composite variables for unknown data at any altitude.

In this spirit, combination of the perfect gas law and the hydrostatic equation permits the atmospheric pressure at any altitude z to be found by the relationship

$$p[z_2] = p[z_1] \exp \left[-\frac{1}{R} \int_{z_1}^{z_2} \frac{g(z) m(z)}{t(z)} dz \right],$$

where

R = universal gas constant

g = effective gravitational acceleration

m = mean molecular mass

t = true kinetic temperature.

The program makes use of the concept of gravitational potential height above the planetary surface, $h(z)$, which is defined as

$$h(z) = \frac{1}{g_0} \int_0^z g(z) dz.$$

Since the mean molecular mass is a function of altitude, we may define the molecular-scale temperature as a composite variable:

$$T = \frac{m_0}{m} t.$$

The combination of this substitution with the concept of potential height allows the pressure to be written as follows:

$$p[h_2] = p[h_1] \exp \left[-\frac{g_0 m_0}{R} \int_{h_1}^{h_2} \frac{dh}{T} \right].$$

Let us define the lapse rate, L, as the variation of molecular-scale temperature with potential height, $L(h) = \partial T / \partial h$. $L(h) = \text{constant}$ for convective equilibrium within a certain height interval. In this case,

$$p[h_2] = p[h_1] \left[\frac{T[h_1]}{T[h_1] + L(h)(h_2 - h_1)} \right]^{m_0 g_0 / RL(h)}.$$

For isothermal equilibrium, $L(h) = 0$; then

$$p[h_2] = p[h_1] \exp \left[-\frac{m_0 g_0}{RT} (h_2 - h_1) \right].$$

It is now possible to evaluate the pressure at all levels of z and h for given values of t/m.

With potential height as the independent variable, the remaining atmospheric-defining equations appear in the following form:

Atmospheric Mass Density

$$\rho_i = \frac{M_0 p_i}{RT_i}.$$

Geometric Altitude Above the Planetary Surface

$$z_i = \frac{rh_i}{r - h_i}. \quad (r = \text{radius vector})$$

Effective Gravitational Acceleration

$$g_i = g_o \left(\frac{r}{r + z_i} \right)^2 .$$

Approximate Number Density

$$n_i = \rho_i (R/m_o k) . \quad (k = \text{Boltzmann's constant})$$

Columnar Mass of the Atmosphere

$$M_i = \frac{p_i}{g_i} .$$

Geometric Pressure Scale Height

$$H_i = \frac{RT_i}{m_o g_i} .$$

Potential Pressure Scale Height

$$H'_i = \frac{RT_i}{m_o g_o} .$$

Potential Density Scale Height

$$H'_{\rho i} = \frac{T_i}{\left(\frac{m_o g_o}{R} + L(h) \right)} .$$

Geometric Density Scale Height

$$\frac{H}{\rho_i} = \frac{g_o}{g_i} \frac{H'}{\rho_i} .$$

Mean Free Path

$$d = \frac{RT_i m}{\sqrt{2} \pi N m_o \bar{\sigma}^2 p_i} .$$

Speed of Sound

$$s = \sqrt{\frac{1.4 RT_i}{m_o}} .$$

III. DERIVATION OF INITIAL PARAMETERS

The program which was used requires the following values: surface gravity, effective planetary radius, atmospheric pressure, temperature, and mean molecular mass as a function of height, as well as temperature gradients in given height intervals. In the case of Venus, it is difficult to specify even so basic a quantity as surface gravity, since the cloud layer prevents an exact determination of the planetary radius.

Thus, some sort of model must be used as a basis, and it appears that one incorporating a greenhouse type of mechanism is most compatible with the results of observation [2]. The model assumes that a thermal source for radio emissions indicates black-body temperatures of approximately 600°K [3]. Recent Mariner measurements show that these temperatures originate from the surface [4]. Let us now consider the data which led us to this model.

The planet Venus is the second closest planet to the sun in the solar system, being about 0.72 the distance from the sun to the earth. It is unique in that its orbit is more nearly circular than that of any other planet. Its physical size, mass and gravity are slightly less than the earth's, but it differs greatly in its temperature, cloudiness, and atmospheric composition. Orbital and physical data of the planet are contained in Table I which has been reprinted from Reference 5.

TABLE I [5]

Orbital and Physical Characteristics of Venus

Distance, Venus to Sun (average)	108.2×10^6 km
Eccentricity of orbit	0.0068
Inclination of orbit to ecliptic	3.39 deg
Inclination of equator to orbital plane	6 deg
Orbital period (sidereal)	224.7 days
Orbital period (synodic from Earth)	583.9 days
Radius (average)	6,100 km
Mass	4.875×10^{24} kg
Flattening	0
Average Density	5.1 g cm^{-3}
Gravitational acceleration	8.8 m sec^{-2}
Rotation period	247 ± 5 days (retrograde)

The exceptional visual brightness of Venus is due to its size, proximity to the sun and to the earth, and its high albedo (0.7 to 0.8 for visible light). The variation of the planet's brightness with solar phase angle is similar to that expected for a smooth sphere reflecting light in a diffuse manner that is characteristic of clouds. Also, the albedo of Venus is much the same as that of terrestrial clouds; thus, the brightness and high albedo are indicative of the presence of a layer of clouds that surround the planet [6].

As seen through a telescope, Venus has a largely featureless appearance. What is actually seen is not the surface of the planet but the tops of the clouds which cover the planet completely, as proved from Mariner II. Faint markings on the surface which change with time indicate that there is some movement, at least of the clouds.

The formation of clouds and various other observations indicate that Venus has an appreciable atmosphere [7]. The most convincing evidence of an atmosphere is found in the occultation of the star Regulus by Venus which occurred July 7, 1959. G. de Vaucouleurs and D. H. Menzel found that the brightness of the star was reduced to half as the light passed through the Venusian atmosphere at an altitude of 56 kilometers above the cloud top.

Two suggested components of the Venusian clouds are ice and magnesium (and calcium) carbonate. These were suggested from the polarization of light reflected from Venus as a function of phase angle. Other possible elements are a solid polymer of carbon suboxide and droplets of hydrocarbon oils. J. S. Strong has claimed spectroscopic evidence of significant amounts of water in the form of ice crystals. With all evidence considered, however, the nature of the particles in the clouds of Venus is uncertain at present. As for the composition above and below the clouds, only one constituent, carbon dioxide, has been positively identified. Other gases which may be present are carbon monoxide, oxygen, nitrogen, argon, and water vapor. At present, the general consensus as to the composition is that the gaseous atmosphere of Venus contains some 90 percent molecular nitrogen, a few percent (5 to 10) carbon dioxide, roughly the same quantity of argon as in the terrestrial atmosphere, and perhaps a little oxygen. There may also be a very small amount of water vapor [8].

Liquid water at a temperature of 573°K (300°C) exerts a vapor pressure of nearly 100 atmospheres. Liquid water at the surface of Venus, therefore, does not seem compatible with the small concentration of water vapor at high altitudes. Furthermore, 673°K (400°C) is above the critical temperature for water, and liquid water cannot exist at all. It is, therefore, very unlikely that water can be found on Venus except in small amounts in the atmosphere.

Inability to distinguish surface features on Venus makes it extremely difficult to determine the planet's rate of rotation. There is no detectable Doppler shift in the spectral lines, and thus it is argued that Venus must be rotating very slowly, if at all. Kotelnikov and Sklovsky (1961) concluded from their measurements that the rotational period was about 11 days. Studies of radar reflections from Venus by Goldstein and Carpenter (1962) indicated that Venus was rotating in a retrograde direction in a period of 230 days plus or minus 40 to 50 days.

A second series of measurements using a "range-gate" method indicated a retrograde motion of 250 days. Both of these measurements assumed the rotational axis to be perpendicular to the orbital plane of Venus; i.e., the equator lies in the orbital plane. During 1964, observations from the Arecibo Observatory and Jet Propulsion Laboratory showed the angle between equatorial and orbital planes to be 6° and confirmed the retrograde direction of rotation of the planet. The rotational period was then determined to be 247 ± 5 days retrograde, and this is the presently accepted rotation rate. If this is correct, then Venus does not present the same face to the sun continuously as the moon does to the earth, but each meridian faces the sun about twice a year (224.7 earth days).

Observations of the temperature of Venus by Pettit and Nicholson (1955) in the range of 8 to 13 microns gave an equivalent black-body temperature of about 230°K . This value has been confirmed by Sinton and Strong (1960) and is in agreement with the temperature calculated from radiation balance after allowing for the high albedo. Opik (1961) measured the temperature to be 234°K and Sinton (1962) measured 236°K . The average temperature given by infrared observations is the same for both illuminated and dark areas of Venus. Brightness temperatures of Venus from the thermal microwave emission from about 3 to 10 centimeters were derived by Mayer, Alsop, and Drake in 1956 and subsequent years. Values obtained in all cases were approximately 600°K . Furthermore, there was some variation with the phase angle, whereas the infrared measurements indicated no significant difference. The brightness temperature for 3.15 centimeters was found to be roughly 700°K on the sunlit and 550°K on the dark side, while 10 centimeters gave about 650°K on the bright side and 575°K on the dark side. This means that there exists a 100-degree difference in temperature between the illuminated and unilluminated sides of the planet. These temperatures measured at superior and inferior conjunction are assumed to approximate the surface temperatures of Venus.

Three different models, the greenhouse, the aeolosphere*, and the ionosphere models, have been proposed for the atmosphere of Venus based on the temperature variations. Experiments carried out by the Mariner II space probe have ruled out the ionosphere model; the greenhouse model appears much more likely than the aeolosphere model although there are still some questionable data [9].

In the greenhouse model (Sagan 1960), the microwave brightness temperature in the vicinity of 650°K on the sunlit side of the planet is regarded as the minimum possible surface temperature, the actual temperature being about 700° , whereas the infrared temperature of about 234° is attributed to the cloud tops. The higher temperature at the surface is then accounted for by the greenhouse effect. The planet absorbs solar radiation which penetrates the clouds and atmosphere.

*The aeolosphere model considers the region between the surface of Venus and the visible clouds as a region where wind is responsible for the supply of heat as well as the grinding and raising of dust. (See also [2]).

The heated surface emits infrared radiation that is absorbed by the carbon dioxide, water vapor, hydrocarbon, etc., in the atmosphere and re-radiated. The surface thus absorbs heat but loses relatively little by radiation; the cloud tops, however, radiate heat to space and are consequently much colder than the surface.

The cloud height has been estimated by assuming an adiabatic lapse rate (g/c_p) between the surface temperature and the top of the clouds. Although the exact composition of the atmosphere, and hence c_p , is unknown, the adiabatic lapse rate is about 8° per kilometer, and the minimum cloud top height then turns out to be 53 kilometers when a surface temperature of 650°K and a cloud top temperature of 230° are used in our model. We have taken this to be closer to 60 kilometers. It is pointed out that the adiabatic lapse rate is the maximum rate of decrease in temperature that a stable atmosphere can have, so that the cloud tops will not be lower than 53 kilometers but may be higher. In fact, L. D. Kaplan (1962) estimated the height to be 95 kilometers.

Using the greenhouse model, one would expect a somewhat lower temperature in the dark areas of the planet, and this is confirmed by observation; but the areas are still warmer than would be expected by comparison with the sunlit and dark sides of the moon. This difference is accounted for by the substantial atmosphere around Venus. The gas is able to transfer heat from the hotter to the colder side, probably by an advection process. This differs from earth where its rapid rotation contributes to the convection of heat to the poles. The cloud tops are at the same temperature on both sides of the planet since it is presumably not affected by the surface temperatures or the atmospheric motions.

Both water vapor and carbon dioxide have significant absorption bands in the infrared region of the spectrum, but nitrogen does not. At one time, it was considered that sufficient water vapor was present in the Venusian atmosphere to permit most of the surface infrared radiation to be absorbed, but this now appears doubtful. The main criticism of the greenhouse model is that carbon dioxide alone would not provide the infrared absorption required to maintain high surface temperatures unless its pressure was very high. However, the surface pressure is probably quite high as indicated by the broadening of the lines in the absorption band spectrum of the carbon dioxide. The lack of water vapor is thus not necessarily a fatal objection to the greenhouse model [10].

The spectra of Venus obtained by Adams and Dunham were studied by Spinrad (1962) using temperature and pressure to effect the band spectrum. It was found that temperatures and pressures varied over a considerable range for different spectral plates, e.g., about 220° to 440°K in temperature and 1.5 to about 5 earth atmospheres in pressure with a definite correlation between temperature and pressure. An increase in one was associated, in general, with an increase in the other. This appears

reasonable since the higher temperatures probably were recorded nearer the planet's surface. The heights at which these temperatures occurred in the atmosphere are still unknown, but the study indicates that the surface pressure is at least as great as the maximum computed pressure (5 atmospheres) and probably much more.

Properties of Venus studied by Mariner II experiments were relatively limited, but contributed significant knowledge by indicating that the centimeter length radiation is mainly from the surface rather than the atmosphere. This, as previously mentioned, ruled out the ionosphere atmospheric model.

Readings of the magnetometer on the Mariner II probe indicated that the magnetic field strength at some 35,000 kilometers from Venus was not significantly different from that in interplanetary space. At most, the field strength at the given distance could not have been more than a hundredth part of the earth's magnetic field at the same distance from the surface. Moreover, there was no evidence of any increase in the flux of charged particles that might be trapped in a radiation belt similar to that in the terrestrial magnetosphere. Although these measurements were made on the sunlit side where the magnetosphere would be compressed, there is no doubt that the magnetic field of Venus is much weaker than the earth's. The fact that a trapped radiation belt does not exist, however, does not affect the probable existence of an ionosphere on Venus. If the Venusian ionosphere is assumed to be about the same as the earth's, it would be from 150 to 300 kilometers thick and have an electron density of about 10^6 electrons per cubic centimeter. It seems unlikely that the charged particle density exceeds 10^8 electrons per cubic centimeter.

A mean dielectric constant of 2.5 for the surface of Venus, which is slightly less than that obtained previously by radar, was found in 1964 using Cal Tech's high resolution twin-dish interferometer radio-telescope [11]. This relatively low dielectric constant previously led Fred Hoyle (1955) to suggest that the surface of Venus may consist of liquid hydrocarbons somewhat like petroleum oil. Although fantastic, the dielectric constant is about 2, and the possible existence of hydrocarbons can be correlated with the carbon dioxide of the atmosphere.

A more conventional view is that the surface of Venus is solid, consisting mainly of silicates and carbonates of magnesium and calcium. The dielectric constant of very dry terrestrial soils ranges from about 2 to 4 in consonance with radar measurements. Because of high temperatures, hydrated minerals such as exist on earth are probably absent.

It has been found that for Venus, like the moon, the bulk of the radar echo power is reflected from smooth areas of the surface near the center of the disk. The way the reflected power falls off toward the limb shows that the surface of Venus is smoother than that of the moon, with the mean surface slopes between a third and a half those of the moon [11].

With the rotational period of Venus being 247 days, it is obvious that the Coriolis force is 1/247 that of the earth. If we consider this negligible and assume the low pressures at the surface to be associated with the high temperatures, the mean wind should be from the anti-solar point to the sub-solar point in the lower levels and the reverse in the higher levels [12].

Data available on which to construct a vertical profile of the elements pressure, temperature, and density are the approximate temperatures at cloud top levels and the surface temperatures on the sunlit and dark side of the planets. Spinrad has computed a pressure of about 0.6 atmospheres at cloud top on the sunlit side, and the occultation of Regulus has given a pressure at about 56 kilometers above cloud top on the dark side of about 2.6×10^{-3} mbs. Accuracy of both of these measurements must be considered order of magnitude only. Using these data, Sagan (1962) has computed pressures of 540 mbs at cloud top height on the sunlit side and 90 mbs on the unilluminated side, but has made no attempt to reduce these to a surface pressure.

The surface pressure of about 30 earth atmospheres has been selected as the most probable mean surface pressure, but the true mean pressure may well lie anywhere between 10 and 100 earth atmospheres, and the literature contains references of even a greater range. Differences in the surface pressure on the dark and sunlit side from the mean value may easily be plus or minus one atmosphere. At high altitudes, the greater pressure will be on the sunlit side, i.e., the opposite of the surface pressure distribution.

IV. RESULTS

The results may be divided into three main sections: maximum, mean, and minimum values. The actual values for each parameter should fall somewhere in this band. The mean values are divided into two cases, one for the dark side and one for the light side. The following molecular weight distribution is used for all four cases: 29.6 from the surface up to 120 kilometers, 29.6 to 29.0 from 120 to 130 kilometers, 29.0 to 25.0 from 130 to 260 kilometers, 25.0 to 5.0 from 260 to 1,260 kilometers, and 5.0 to 1.5 from 1,260 to 15,000 kilometers. The cloudtop is taken to be at 60 kilometers except in the maximum case, where it is taken to be at

80 kilometers. The atmosphere is considered to be initially 10 percent CO₂ and 90 percent N₂ in all cases; and the thermosphere lapse rate is taken as 14.85°K/km, with the thermosphere lapse rate beginning at 310-340 kilometers. In all cases, the planetary radius was taken as 6,040 kilometers. All lapse rates used appear in the printout.

In the maximum case, surface pressure is 100 atmospheres, and surface temperature is 800°K. The average temperature lapse rate in the troposphere is -7.08°K/km, with a tropopause height of 90 kilometers.

In the mean case, the surface pressure is 30 atmospheres with a surface temperature of 700°K for the light side and 600°K for the dark side. The tropopause height is 70 kilometers, with an average temperature lapse rate in the troposphere of -7.70°K/km for the bright side and -6.10°K/km for the dark side.

In the minimum case the surface pressure is set at 10 atmospheres, and the surface temperature at 600°K. The average temperature lapse rate in the troposphere is -6.10°K/km, with a tropopause height of 70 kilometers.

The results are presented in printout form, with the printout being broken up into four cases. In the printout, the parameters are presented in the following units: atmospheric mass density in gm/cm³, gravity in cm/sec², geometric scale height in cm, pressure in dynes/cm², potential density scale height in cm, geometric density scale height in cm, mean free path in cm, and speed of sound in cm/sec. The values calculated for speed of sound are physically meaningless after about 100 kilometers. Atmospheric density, pressure and temperature are presented in Figures 1 through 3. The authors are grateful to Thomas S. Dollman, NASA, for aid in the generation of these graphs.

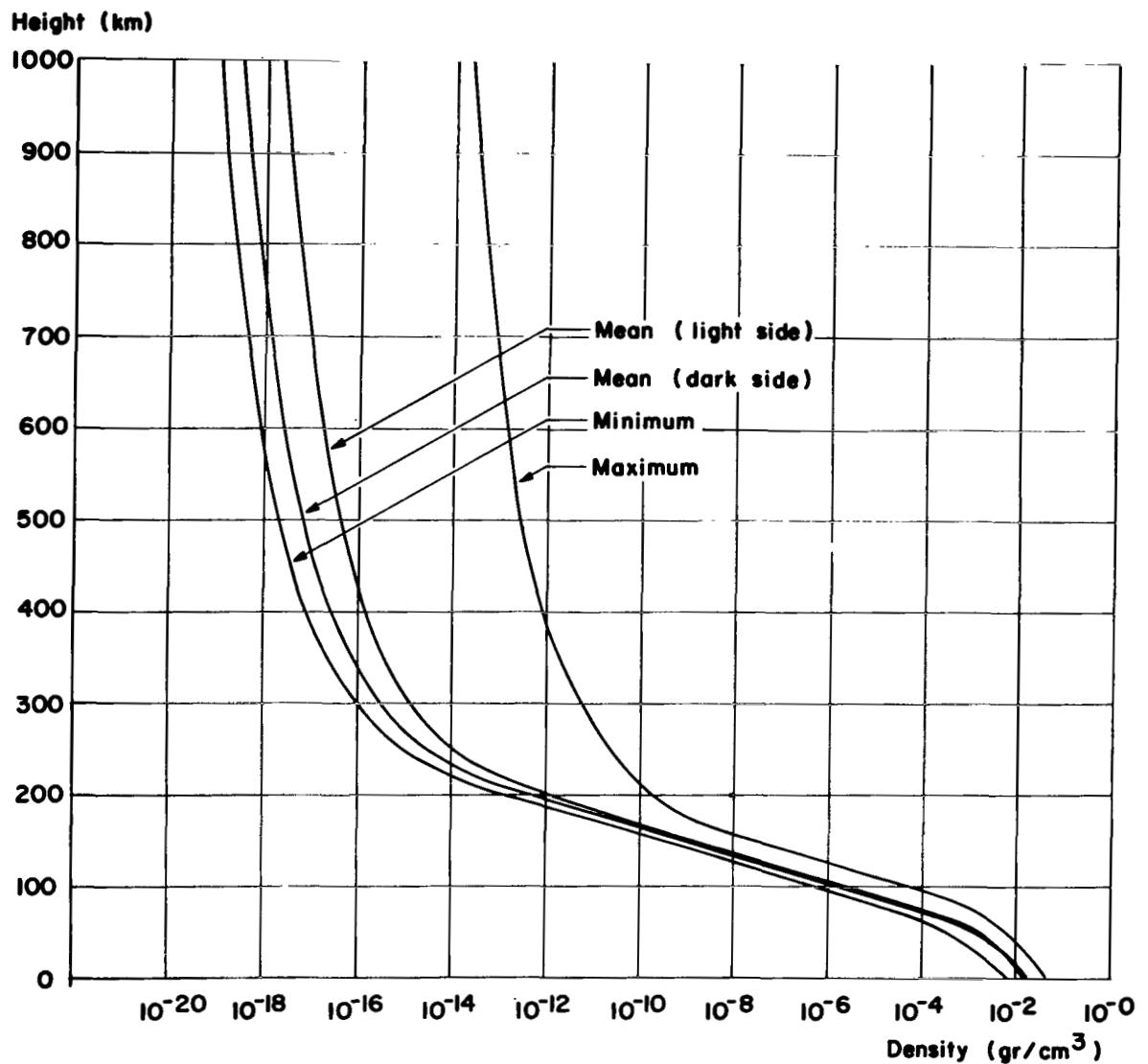


Fig. I. VARIATION OF ATMOSPHERIC DENSITY
WITH HEIGHT FOR FOUR CASES OF SURFACE CONDITIONS

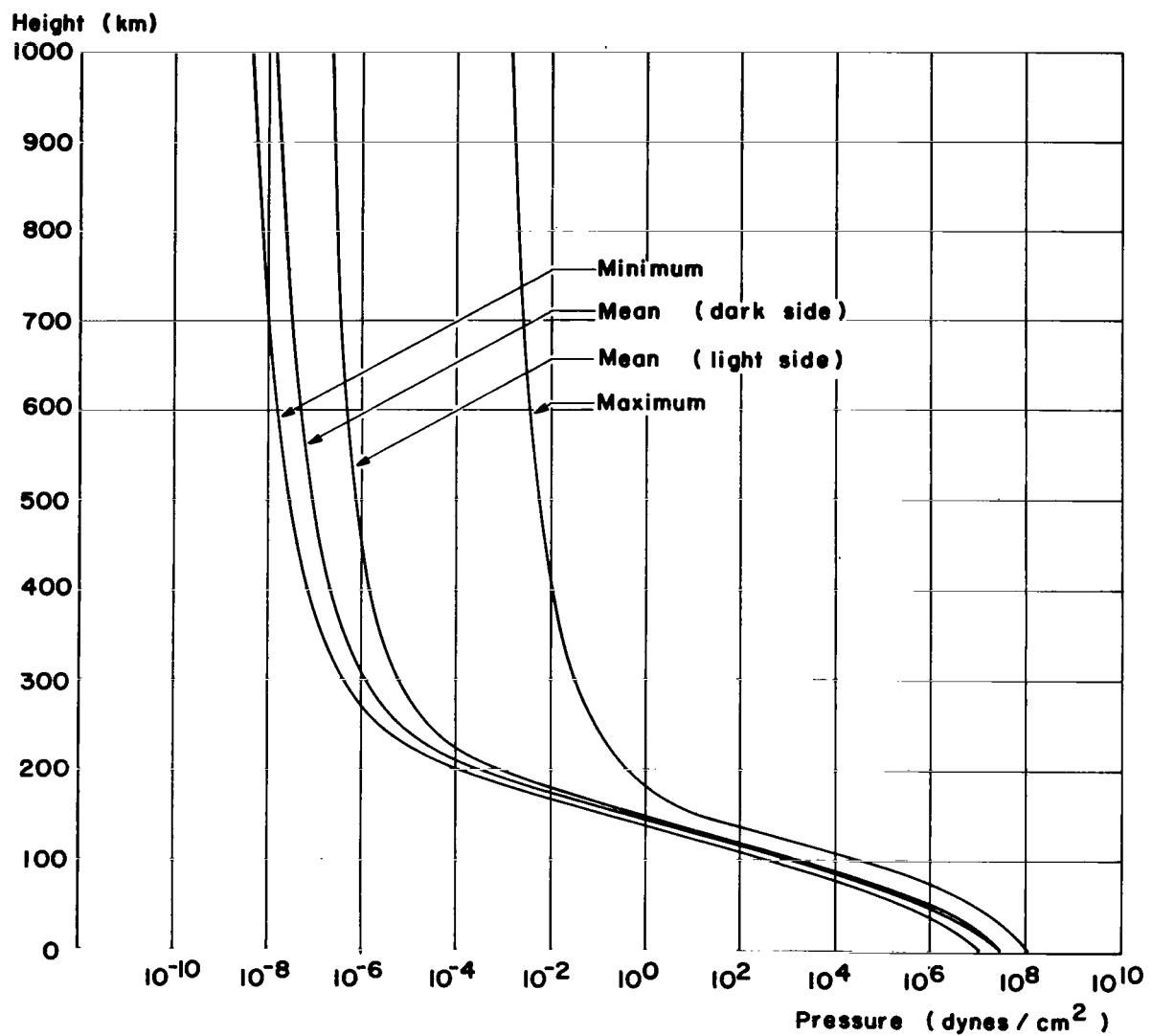


Fig. 2. VARIATION OF ATMOSPHERIC PRESSURE
WITH HEIGHT FOR FOUR CASES OF SURFACE CONDITIONS

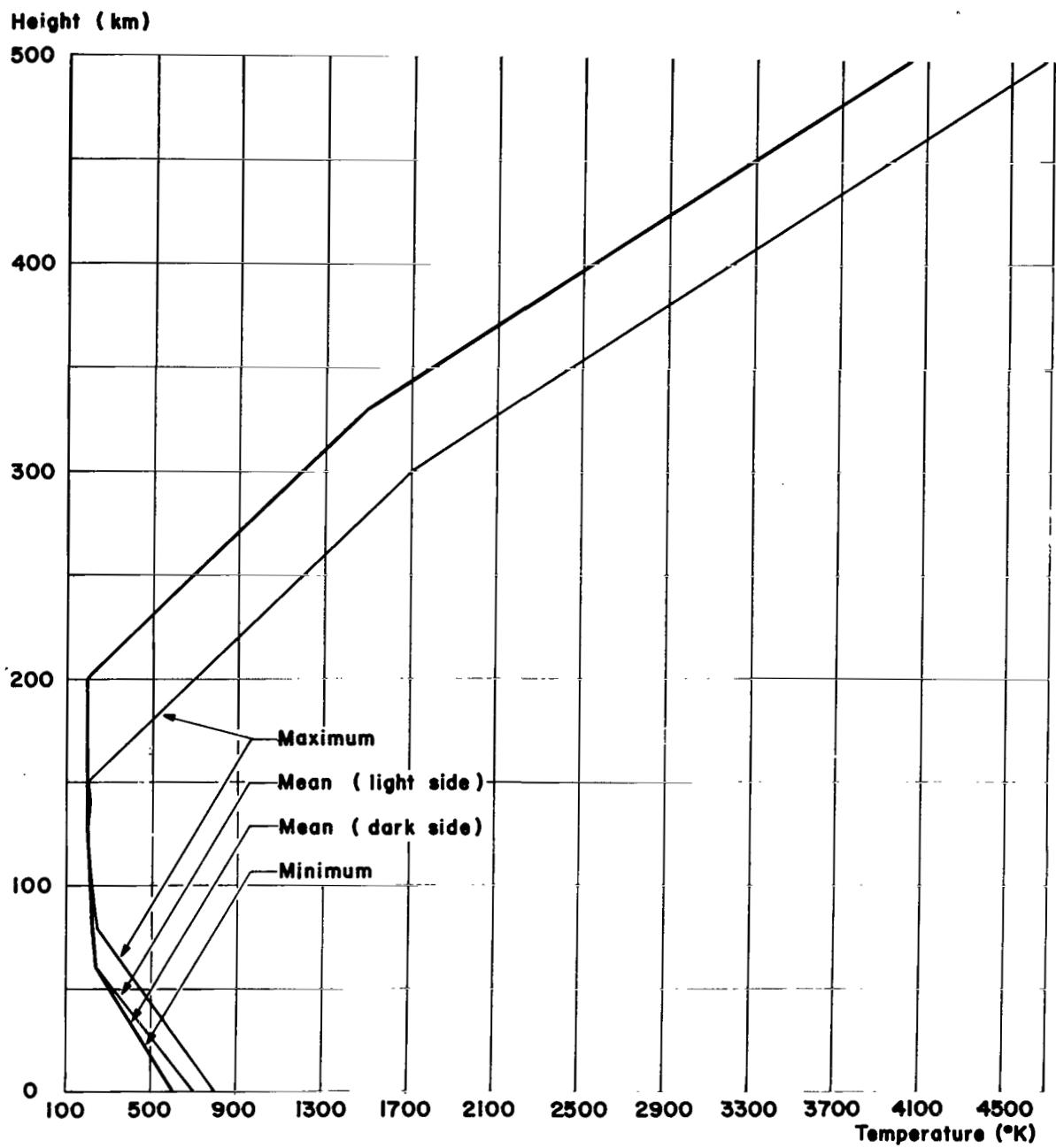


FIG. 3. VARIATION OF ATMOSPHERIC TEMPERATURE
WITH HEIGHT FOR FOUR CASES OF SURFACE CONDITIONS
AND LAPSE RATES

MEAN (Lightside)

INPUT CONSTANTS

PLANET RADIUS= 6.0400000E 08 SURFACE GRAVITY= 8.8000000E .02
 MOLECULAR MASS= 2.9600000E 01

INITIAL CONDITIONS

HEIGHT= 0 PRESSURE= 3.0000000E 07
 TEMPERATURE= 7.0000000E 02

HEIGHT	PRESSURE	TEMPERATURE	DENSITY
PRESSURE SCALE HEIGHT	COLUMNAR MASS	MOLECULAR MASS	GRAVITY
SPEED OF SOUND	NUMBER DENSITY	DENSITY SCALE HEIGHT	TL
MEAN FREE PATH	GEOMETRIC PRESS.	POTENTIAL DENSITY	XML
	SCALE HEIGHT	SCALE HEIGHT	
0	3.0000000E 07	7.0000000E 02	1.52575406E-02
2.23436463E 06	3.40909091E 04	2.9600000E 01	8.8000000E 02
5.24665344E 04	3.10559006E 20	2.97087061E 06	-7.76670000E-05
5.27273492E-07	2.23436463E 06	2.97087061E 06	0
1.00000000E 05	2.86797641E 07	6.92233300E 02	1.47497414E-02
2.20957372E 06	3.26014335E 04	2.96000000E 01	8.79708682E 02
5.21746569E 04	3.00223028E 20	2.93888085E 06	-7.76670000E-05
5.45426288E-07	2.21030543E 06	2.93790796E 06	0
2.00000000E 05	2.74037095E 07	6.84466600E 02	1.42533980E-02
2.18478281E 06	3.11612053E 04	2.96000000E 01	8.79417508E 02
5.18811374E 04	2.90120226E 20	2.90686942E 06	-7.76670000E-05
5.64419564E-07	2.18622992E 06	2.90494530E 06	0
3.00000000E 05	2.61708339E 07	6.76699900E 02	1.37683776E-02
2.15999189E 06	2.97691339E 04	2.96000000E 01	8.79126479E 02
5.15859478E 04	2.80247897E 20	2.87483631E 06	-7.76670000E-05
5.84302446E-07	2.16213811E 06	2.87198264E 06	0

4.0000000E 05	2.49801468E 07	6.68933200E 02	1.32945473E-02
2.13520098E 06	2.84241409E 04	2.96000000E 01	8.78835594E 02
5.12890593E 04	2.70603337E 20	2.84278152E 06	-7.76670000E-05
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5.00000000E 05	2.38306692E 07	6.61166500E 02	1.28317744E-02
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6.26951225E-07	2.11390557E 06	2.80605732E 06	0
6.00000000E 05	2.27214340E 07	6.53399800E 02	1.23799263E-02
2.08561915E 06	2.58711345E 04	2.96000000E 01	8.78254257E 02
5.06900660E 04	2.51986720E 20	2.77860686E 06	-7.76670000E-05
6.49833974E-07	2.08976482E 06	2.77309466E 06	0
7.00000000E 05	2.16514856E 07	6.45633100E 02	1.19388702E-02
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<u>7.0000000E 06</u>	<u>9.30918158E 04</u>	<u>2.28331000E 02</u>	<u>1.45146959E-04</u>
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<u>2.99651046E 04</u>	<u>2.95438804E 18</u>	<u>7.59551467E 05</u>	<u>-5.66700000E-06</u>
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<u>2.95909128E 04</u>	<u>7.55051681E 17</u>	<u>7.43126517E 05</u>	<u>-5.66700000E-06</u>
<u>2.16871952E-04</u>	<u>7.29684267E 05</u>	<u>7.23825355E 05</u>	<u>0</u>
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<u>1.87912318E 05</u>	<u>5.99078404E 05</u>	<u>1.95351420E 07</u>	<u>1.48940000E-04</u>
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<u>1.95070117E 05</u>	<u>5.31657686E 05</u>	<u>2.09732334E 07</u>	<u>1.48940000E-04</u>
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<u>8.00000000F 08</u>	<u>8.54059223E-08</u>	<u>1.15736976E 05</u>	<u>3.45162342E-20</u>
<u>2.81178369E 09</u>	<u>5.24403586E-10</u>	<u>3.88900000E 00</u>	<u>1.62862964E 02</u>
<u>1.86121399E 06</u>	<u>5.34732733E 03</u>	<u>3.28963062E 09</u>	<u>1.48940000E-04</u>
<u>3.06226871E 10</u>	<u>1.51929548E 10</u>	<u>6.08817037E 0A</u>	<u>-3.40000000E-09</u>
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<u>2.87308634E 09</u>	<u>5.30040403E-10</u>	<u>3.85500000E 00</u>	<u>1.60567531E 02</u>
<u>1.88139373E 06</u>	<u>5.26092706E 03</u>	<u>3.38600688E 09</u>	<u>1.48940000E-04</u>
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<u>1.90171273E 06</u>	<u>5.17714536E 03</u>	<u>3.48430805E 09</u>	<u>1.48940000E-04</u>
<u>3.16293093E 10</u>	<u>1.63164329E 10</u>	<u>6.26859834E 0A</u>	<u>-3.40000000E-09</u>
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<u>2.99899391E 09</u>	<u>5.41455106E-10</u>	<u>3.78700000E 00</u>	<u>1.56119894E 02</u>
<u>1.92217598E 06</u>	<u>5.09587123E 03</u>	<u>3.58455808E 09</u>	<u>1.48940000E-04</u>
<u>3.21337656E 10</u>	<u>1.69044097E 10</u>	<u>6.35932757E 0A</u>	<u>-3.40000000E-09</u>
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<u>3.06365867E 09</u>	<u>5.47232930E-10</u>	<u>3.75300000E 00</u>	<u>1.53965056E 02</u>
<u>1.94278858E 06</u>	<u>5.01699973E 03</u>	<u>3.68678110E 09</u>	<u>1.48940000E-04</u>
<u>3.26389357E 10</u>	<u>1.75105943E 10</u>	<u>6.45040292E 0A</u>	<u>-3.40000000E-09</u>
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<u>3.12950579E 09</u>	<u>5.53057709E-10</u>	<u>3.71900000E 00</u>	<u>1.51054525E 02</u>
<u>1.96355574E 06</u>	<u>4.94043151E 03</u>	<u>3.79100143E 09</u>	<u>1.48940000E-04</u>
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<u>3.19656800E 09</u>	<u>5.58929437E-10</u>	<u>3.68500000E 00</u>	<u>1.49787094E 02</u>

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9.20000000E 08	8.22640926E-08	1.33609776E 05	2.57777915E-20
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9.30000000E 08	8.20410095E-08	1.35099176E 05	2.51761424E-20
3.70304626E 09	6.01347023E-10	3.44700000E 00	1.36428728E 02
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9.40000000E 08	8.18231349E-08	1.36588576E 05	2.45905155E-20
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9.70000000E 08	8.11994089E-08	1.41056776E 05	2.29238576E-20
4.02515393E 09	6.26622196E-10	3.31100000E 00	1.29582720E 02
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9.80000000E 08	8.10010399E-08	1.42546176E 05	2.23965473E-20
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9.90000000E 08	8.08072393E-08	1.44035576E 05	2.18825058E-20
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5.51163885E 09	7.28306573E-10	2.80100000E 0n	1.08014492E 02
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1.16000000E 09	7.81291171E-08	1.69355376E 05	1.47870231E-20
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6.26970609E 09	7.72055605E-10	2.59700000E 0n	1.00871121E 02
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5.00051962E 10	5.46969368E 10	9.76802691E 08	-3.40000000E-09
1.20000000E 09	7.76386289E-08	1.75312976E 05	1.34704540E-20
6.54957249E 09	7.87035594E-10	2.52900000E 0n	9.86469093E 01
2.84061143E 06	3.20911077E 03	8.90069609E 09	1.48940000E-04
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1.22000000E 09	7.74101983E-08	1.78291776E 05	1.28513304E-20
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2.90394952E 06	3.14621055E 03	9.29181161E 09	1.48940000E-04
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1.24000000E 09	7.71923886E-08	1.81270576E 05	1.22563025E-20
7.15702174E 09	8.17597894E-10	2.39300000E 0n	9.44136344E 01
2.96941927E 06	3.08580216E 03	9.69523821E 09	1.48940000E-04
5.30654667E 10	6.67083644E 10	1.04018486E 09	-3.40000000E-09
1.26000000E 09	7.69847904E-08	1.84249376E 05	1.16839979E-20
7.48739576E 09	8.33182613E-10	2.32500000E 0n	9.23984601E 01
3.03718152E 06	3.02774865E 03	1.01112420E 1n	1.48940000E-04
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3.10741343E 06	2.97192268E 03	1.05400935E 1n	1.48940000E-04
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1.30000000E 09	7.65987048E-08	1.90206976E 05	1.06025506E-20
8.20972103E 09	8.64965459E-10	2.18900000E 00	8.85569522E 01
3.18031073E 06	2.91820568E 03	1.09820677E 10	1.48940000E-04
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3.25609040E 06	2.86648717E 03	1.14374443E 10	1.48940000E-04
5.71255065E 10	8.73209510E 10	1.12717859E 09	-3.40000000E-09
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9.82774649E 09	8.97574892E-10	2.05300000E 00	8.49501262E 01
3.33499380E 06	2.81666407E 03	1.19065076E 10	1.48940000E-04
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9.47879378E 09	9.14192952E-10	1.98500000E 00	8.32287903E 01
3.41729044E 06	2.76864007E 03	1.23895469E 10	1.48940000E-04
5.91443914E 10	1.00221792E 11	1.17178069E 09	-3.40000000E-09
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9.96184025E 09	9.31021762E-10	1.91700000E 00	8.15592482E 01
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1.30019393E 10	1.01837770E-09	1.57700000E 00	7.39198574E 01
4.00229799E 06	2.51361528E 03	1.55981062E 10	1.48940000E-04
6.51450255E 10	1.54785290E 11	1.31023839E 09	-3.40000000E-09

1.50000000E 09	7.51683659E-08	2.19994976E 05	6.20127788E-21
1.37743541E 10	1.03650173E-09	1.50900000E 00	7.25212162E 01
4.11946650E 06	2.47595792E 03	1.61875014E 10	1.48940000E-04
6.61358298E 10	1.67143248E 11	1.33401965E 09	-3.40000000E-09

END OF PROBLEM

INPUT CONSTANTS

MEAN (Darkside)

PLANET RADIUS = 6.04000000E 08 SURFACE GRAVITY = 8.80000000E 02
MOLECULAR MASS = 2.96000000E 01

INITIAL CONDITIONS

**HEIGHT = 0 PRESSURE = 3.00000000E 07
 TEMPERATURE = 6.00000000E 02**

HEIGHT	PRESSURE	TEMPERATURE	DENSITY
PRESSURE SCALE HEIGHT	COLUMNAR MASS	MOLECULAR MASS	GRAVITY
SPEED OF SOUND	NUMBER DENSITY	DENSITY SCALE HEIGHT	TL
MEAN FREE PATH	GEOMETRIC PRESS. SCALE HEIGHT	POTENTIAL DENSITY SCALE HEIGHT	XML
0	3.00000000E 07	6.00000000E 02	1.78004640E-02
1.91516969E 06	3.40909091E 04	2.96000000E 01	8.80000000E 02
4.85745721E 04	3.62250590E 20	2.37823283E 06	-6.10000000E-05
4.51948708E-07	1.91516969E 06	2.37823283E 06	0
1.00000000E 05	2.84661440E 07	5.93900000E 02	1.70638347E-02
1.89569879E 06	3.23586030E 04	2.96000000E 01	8.79708682E 02
4.83270205E 04	3.47259722E 20	2.35483368E 06	-6.10000000E-05
4.71458898E-07	1.89632656E 06	2.35405413E 06	0
2.00000000E 05	2.69960802E 07	5.87800000E 02	1.63505531E-02

1.8762279E 06	3.06976834E 04	2.96000000E 01	8.79417508E 02
4.80781944E 04	3.32743995E 20	2.33141865E 04	-6.10000000E-05
4.92025968E-07	1.87747064E 06	2.32987543E 04	0
3.00000000E 05	2.55877767E 07	5.81700000E 02	1.56601100E-02
1.85675701E 06	2.91059106E 04	2.96000000E 01	8.79126479E 02
4.78280737E 04	3.18693045E 20	2.30798772E 04	-6.10000000E-05
5.13719043E-07	1.85860193E 06	2.30569673E 04	0
4.00000000E 05	2.42392457E 07	5.75600000E 02	1.49920021E-02
1.83728612E 06	2.75810924E 04	2.96000000E 01	8.78835594E 02
4.75766382E 04	3.05096632E 20	2.28454090E 04	-6.10000000E-05
5.36612564E-07	1.83972042E 06	2.28151803E 04	0
5.00000000E 05	2.29485437E 07	5.69500000E 02	1.43457323E-02
1.81781523E 06	2.61210838E 04	2.96000000E 01	8.78544853E 02
4.73238667E 04	2.91944636E 20	2.26107819E 04	-6.10000000E-05
5.60786758E-07	1.82082610E 06	2.25733933E 04	0
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1.79834434E 06	2.47237864E 04	2.96000000E 01	8.78254257E 02
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7.00000000E 05	2.05330694E 07	5.57300000E 02	1.31167473E-02
1.77887344E 06	2.33871480E 04	2.96000000E 01	8.77963805E 02
4.68142295E 04	2.66934022E 20	2.21410505E 04	-6.10000000E-05
6.13330159E-07	1.78299905E 06	2.20898192E 04	0
8.00000000E 05	1.94046253E 07	5.51200000E 02	1.25330673E-02
1.75940255E 06	2.21091617E 04	2.96000000E 01	8.77673497E 02
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1.73993166E 06	2.08878661E 04	2.96000000E 01	8.77383333E 02
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1.72046077E 06	1.97213441E 04	2.96000000E 01	8.77093313E 02
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<u>4.30782792E 04</u>	<u>1.34162898E 20</u>	<u>1.88350938E 06</u>	<u>-6.10000000E-05</u>
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<u>4.27989486E 04</u>	<u>1.27134294E 20</u>	<u>1.85977579E 06</u>	<u>-6.10000000E-05</u>
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<u>4.25177829E 04</u>	<u>1.20388481E 20</u>	<u>1.83602623E 06</u>	<u>-6.10000000E-05</u>
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<u>4.13740173E 04</u>	<u>9.60778674E 19</u>	<u>1.74086823E 06</u>	<u>-6.10000000F-05</u>
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<u>4.07901095E 04</u>	<u>8.54207471E 19</u>	<u>1.69319330E 06</u>	<u>-6.10000000E-05</u>
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<u>4.04949984E 04</u>	<u>8.04412010E 19</u>	<u>1.66933185E 06</u>	<u>-6.10000000E-05</u>

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2.97592898E-06	1.22873483E 06	1.50779961E 06	0
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3.18169978E-06	1.20942915E 06	1.48362091E 06	0
3.80000000E 06	2.44326167E 06	3.68200000E 02	2.36236781E-03
1.17527580E 06	2.81147887E 03	2.96000000E 01	8.69030778E 02
3.80518039E 04	4.80756644E 19	1.47786382E 06	-6.10000000E-05
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1.15581491E 06	2.58116423E 03	2.96000000E 01	8.68744889E 02
3.77352838E 04	4.48661159E 19	1.45385821E 06	-6.10000000E-05
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<u>4.10000000E 06</u>	<u>1.88045350E 06</u>	<u>3.49900000E 02</u>	<u>1.91328636E-03</u>
<u>1.11686312E 06</u>	<u>2.16598805E 03</u>	<u>2.96000000E 01</u>	<u>8.68173534E 02</u>
<u>3.70941419E 04</u>	<u>3.89365756E 19</u>	<u>1.40579887E 06</u>	<u>-6.10000000E-05</u>
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<u>4.20000000E 06</u>	<u>1.71804467E 06</u>	<u>3.43800000E 02</u>	<u>1.77905714E-03</u>
<u>1.09739223E 06</u>	<u>1.97956940E 03</u>	<u>2.96000000E 01</u>	<u>8.67888068E 02</u>
<u>3.67693789E 04</u>	<u>3.62049270E 19</u>	<u>1.38174514E 06</u>	<u>-6.10000000E-05</u>
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<u>1.07792134E 06</u>	<u>1.80627179E 03</u>	<u>2.96000000E 01</u>	<u>8.67602743E 02</u>
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<u>4.40000000E 06</u>	<u>1.42707136E 06</u>	<u>3.31600000E 02</u>	<u>1.53211896E-03</u>
<u>1.05845045E 06</u>	<u>1.64538506E 03</u>	<u>2.96000000E 01</u>	<u>8.67317559E 02</u>
<u>3.61110918E 04</u>	<u>3.11795803E 19</u>	<u>1.33358952E 06</u>	<u>-6.10000000E-05</u>
<u>5.25083034E-06</u>	<u>1.07392775E 06</u>	<u>1.31437001E 06</u>	<u>0</u>
<u>4.50000000E 06</u>	<u>1.29727617E 06</u>	<u>3.25500000E 02</u>	<u>1.41887052E-03</u>
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<u>3.57774064E 04</u>	<u>2.88749037E 19</u>	<u>1.30948763E 06</u>	<u>-6.10000000E-05</u>
<u>5.66993012E-06</u>	<u>1.05451871E 06</u>	<u>1.29019131E 06</u>	<u>0</u>
<u>4.60000000E 06</u>	<u>1.17716056E 06</u>	<u>3.19400000E 02</u>	<u>1.31208542E-03</u>
<u>1.01950866E 06</u>	<u>1.35813534E 03</u>	<u>2.96000000E 01</u>	<u>8.66747611E 02</u>
<u>3.54405795E 04</u>	<u>2.67017600E 19</u>	<u>1.28536968E 06</u>	<u>-6.10000000E-05</u>
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<u>4.70000000E 06</u>	<u>1.06616706E 06</u>	<u>3.13300000E 02</u>	<u>1.21150771E-03</u>
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<u>3.51005204E 04</u>	<u>2.46549407E 19</u>	<u>1.26123566E 06</u>	<u>-6.10000000E-05</u>
<u>6.64040074E-06</u>	<u>1.01566183E 06</u>	<u>1.24183391E 06</u>	<u>0</u>
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<u>3.47571345E 04</u>	<u>2.27293489E 19</u>	<u>1.23708557E 06</u>	<u>-6.10000000E-05</u>
<u>7.20298419E-06</u>	<u>9.96213977E 05</u>	<u>1.21765521E 06</u>	<u>0</u>
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<u>9.61095988E 05</u>	<u>1.00408094E 03</u>	<u>2.96000000E 01</u>	<u>8.65893743E 02</u>

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9.22154204E 05	8.12451074E 02	2.96000000E 01	8.65325198E 02
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1.01428955E-05	9.18293110E 05	1.12094041E 06	0
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<u>7.31235619E 04</u>	<u>5.04183399E-06</u>	<u>3.59640067E 06</u>	<u>1.00000000E-04</u>
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<u>9.10773679E 05</u>	<u>2.91323350E 02</u>	<u>8.49490797E 08</u>	<u>1.48940000E-04</u>
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<u>4.80000000E 08</u>	<u>2.63874277E-09</u>	<u>6.80761780E 04</u>	<u>4.32058849E-21</u>
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<u>9.24679212E 05</u>	<u>2.80828377E 02</u>	<u>8.87627136E 08</u>	<u>1.48940000E-04</u>
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<u>4.90000000E 08</u>	<u>2.60170303E-09</u>	<u>6.95655780E 04</u>	<u>4.13448033E-21</u>
<u>7.15079158E 08</u>	<u>9.69919781E-12</u>	<u>9.19153400E 00</u>	<u>2.68238990E 02</u>
<u>9.38604028E 05</u>	<u>2.70958277E 02</u>	<u>9.26883675E 08</u>	<u>1.48940000E-04</u>
<u>6.04221019E 11</u>	<u>2.34592912E 09</u>	<u>2.82529933E 08</u>	<u>-7.61540000E-09</u>
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<u>7.36491012E 08</u>	<u>9.74271130E-12</u>	<u>9.11538000E 00</u>	<u>2.63401596E 02</u>
<u>9.52552847E 05</u>	<u>2.61663306E 02</u>	<u>9.67281432E 08</u>	<u>1.48940000E-04</u>
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<u>7.80406265E 08</u>	<u>9.83706386E-12</u>	<u>8.96307200E 00</u>	<u>2.54111270E 02</u>
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<u>1.02281657E 06</u>	<u>2.22387847E 02</u>	<u>1.18714378E 09</u>	<u>1.48940000E-04</u>
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<u>2.29339147E 09</u>	<u>1.35144430E-11</u>	<u>5.68845000E 00</u>	<u>1.32939647E 02</u>
<u>1.68090996E 06</u>	<u>9.42686639E 01</u>	<u>4.37019837E 09</u>	<u>1.48940000E-04</u>
<u>1.73672437E 12</u>	<u>1.51812085E 10</u>	<u>6.60196167E 08</u>	<u>-7.61540000E-09</u>
<u>9.60000000E 08</u>	<u>1.78893413E-09</u>	<u>1.39567378E 05</u>	<u>8.65208161E-22</u>
<u>2.34958452E 09</u>	<u>1.36304847E-11</u>	<u>5.61229600E 00</u>	<u>1.31245086E 02</u>
<u>1.70137830E 06</u>	<u>9.28644582E 01</u>	<u>4.49168254E 09</u>	<u>1.48940000E-04</u>
<u>1.76298542E 12</u>	<u>1.57539946E 10</u>	<u>6.69899161E 08</u>	<u>-7.61540000E-09</u>
<u>9.70000000E 08</u>	<u>1.78147899E-09</u>	<u>1.41056778E 05</u>	<u>8.40937217E-22</u>
<u>2.40732352E 09</u>	<u>1.37478128E-11</u>	<u>5.53614200E 00</u>	<u>1.29582720E 02</u>
<u>1.72215637E 06</u>	<u>9.15010003E 01</u>	<u>4.61570971E 09</u>	<u>1.48940000E-04</u>
<u>1.78925570E 12</u>	<u>1.63482036E 10</u>	<u>6.79677524E 08</u>	<u>-7.61540000E-09</u>
<u>9.80000000E 08</u>	<u>1.77423357E-09</u>	<u>1.42546178E 05</u>	<u>8.17365892E-22</u>
<u>2.46667316E 09</u>	<u>1.38664279E-11</u>	<u>5.45998800E 00</u>	<u>1.27951740E 02</u>
<u>1.74325596E 06</u>	<u>9.01766947E 01</u>	<u>4.74232146E 09</u>	<u>1.48940000E-04</u>
<u>1.81553213E 12</u>	<u>1.69647743E 10</u>	<u>6.89532137E 08</u>	<u>-7.61540000E-09</u>
<u>9.90000000E 08</u>	<u>1.76719188E-09</u>	<u>1.44035578E 05</u>	<u>7.94465782E-22</u>
<u>2.52770181E 09</u>	<u>1.39863307E-11</u>	<u>5.38383400E 00</u>	<u>1.26351358E 02</u>
<u>1.76468939E 06</u>	<u>8.88900245E 01</u>	<u>4.87156003E 09</u>	<u>1.48940000E-04</u>
<u>1.84181169E 12</u>	<u>1.76046987E 10</u>	<u>6.99463895E 08</u>	<u>-7.61540000E-09</u>
<u>1.00000000E 09</u>	<u>1.76034815E-09</u>	<u>1.45524978E 05</u>	<u>7.72209901E-22</u>
<u>2.59048171E 09</u>	<u>1.41075224E-11</u>	<u>5.30768000E 00</u>	<u>1.24780816E 02</u>
<u>1.78646956E 06</u>	<u>8.76395470E 01</u>	<u>5.00346834E 09</u>	<u>1.48940000E-04</u>
<u>1.86809142E 12</u>	<u>1.82690255E 10</u>	<u>7.09473708E 08</u>	<u>-7.61540000E-09</u>
<u>1.02000000E 09</u>	<u>1.74732893E-09</u>	<u>1.48503778E 05</u>	<u>7.29569688E-22</u>
<u>2.72160575E 09</u>	<u>1.43545694E-11</u>	<u>5.15537200E 00</u>	<u>1.21726322E 02</u>
<u>1.83112487E 06</u>	<u>8.52464423E 01</u>	<u>5.27546921E 09</u>	<u>1.48940000E-04</u>
<u>1.92053394E 12</u>	<u>1.96753917E 10</u>	<u>7.29731208E 08</u>	<u>-7.61540000E-09</u>
<u>1.04000000E 09</u>	<u>1.73503464E-09</u>	<u>1.51482578E 05</u>	<u>6.89209301E-22</u>
<u>2.86071339E 09</u>	<u>1.46068049E-11</u>	<u>5.00306400E 00</u>	<u>1.18782626E 02</u>
<u>1.87733825E 06</u>	<u>8.29821267E 01</u>	<u>5.55868111E 09</u>	<u>1.48940000E-04</u>
<u>1.97293915E 12</u>	<u>2.11935690E 10</u>	<u>7.50312206E 08</u>	<u>-7.61540000E-09</u>
<u>1.06000000E 09</u>	<u>1.72342698E-09</u>	<u>1.54461378E 05</u>	<u>6.50956577E-22</u>
<u>3.00855666E 09</u>	<u>1.48642493E-11</u>	<u>4.85075600E 00</u>	<u>1.15944434E 02</u>

1.92523812E 06	8.08373522E 01	5.85347261E 00	1.48940000E-04
2.02528512E 12	2.28344714E 10	7.71224511E 08	-7.61540000E-09
1.08000000E 09	1.71247050E-09	1.57440178E 05	6.14655198E-22
3.16598511E 09	1.51269274E-11	4.69844800E 00	1.13206764E 02
1.97496675E 06	7.88037027E 01	6.16022422E 00	1.48940000E-04
2.07755068E 12	2.46104279E 10	7.92476190E 08	-7.61540000E-09
1.10000000E 09	1.70213237E-09	1.60418978E 05	5.80162961E-22
3.33396211E 09	1.53948677E-11	4.54614000E 00	1.10564923E 02
2.02668234E 06	7.68735050E 01	6.47932890E 09	1.48940000E-04
2.12971538E 12	2.65354198E 10	8.14075571E 08	-7.61540000E-09
1.12000000E 09	1.69238213E-09	1.63397778E 05	5.47350275E-22
3.51358463E 09	1.56681025E-11	4.39383200E 00	1.08014492E 02
2.08056153E 06	7.50397508E 01	6.81119259E 09	1.48940000E-04
2.18175946E 12	2.86253671E 10	8.36031257E 08	-7.61540000E-09
1.14000000E 09	1.68319149E-09	1.66376578E 05	5.16098833E-22
3.70610721E 09	1.59466675E-11	4.24152400E 00	1.05551300E 02
2.13680230E 06	7.32960276E 01	7.15623474E 09	1.48940000E-04
2.23366384E 12	3.08984763E 10	8.58352139E 08	-7.61540000E-09
1.16000000E 09	1.67453414E-09	1.69355378E 05	4.86300451E-22
3.91297129E 09	1.62306016E-11	4.08921600E 00	1.03171415E 02
2.19562762E 06	7.16364591E 01	7.51488883E 09	1.48940000E-04
2.28541009E 12	3.33756664E 10	8.81047404E 08	-7.61540000E-09
1.18000000E 09	1.66638556E-09	1.72334178E 05	4.57856042E-22
4.13584135E 09	1.65199468E-11	3.93690800E 00	1.00871121E 02
2.25728965E 06	7.00556511E 01	7.88760305E 09	1.48940000E-04
2.33698044E 12	3.60810937E 10	9.04126552E 08	-7.61540000E-09
1.20000000E 09	1.65872290E-09	1.75312978E 05	4.30674707E-22
4.37664985E 09	1.68147478E-11	3.78460000E 00	9.86469093E 01
2.32207507E 06	6.85486446E 01	8.27484086E 09	1.48940000E-04
2.38835775E 12	3.90428032E 10	9.27599404E 08	-7.61540000E-09
1.22000000E 09	1.65152485E-09	1.78291778E 05	4.04672934E-22
4.63765333E 09	1.71150523E-11	3.63229200E 00	9.64954601E 01
2.39031147E 06	6.71108739E 01	8.67708167E 09	1.48940000E-04
2.43952547E 12	4.22935434E 10	9.51476123E 08	-7.61540000E-09
1.24000000E 09	1.64477147E-09	1.81270578E 05	3.79773888E-22
4.92150343E 09	1.74209105E-11	3.47998400E 00	9.44136344E 01
2.46237532E 06	6.57381296E 01	9.09482153E 09	1.48940000E-04
2.49046766E 12	4.58717965E 10	9.75767222E 08	-7.61540000E-09

<u>1.26000000E 09</u>	<u>1.63844414E-09</u>	<u>1.84249378E 05</u>	<u>3.55906772E-22</u>
<u>5.23133722E 09</u>	<u>1.77323750E-11</u>	<u>3.32767600E 00</u>	<u>9.23984601E 01</u>
<u>2.53870192E 06</u>	<u>6.44265250E 01</u>	<u>9.52857387E 09</u>	<u>1.48940000E-04</u>
<u>2.54116897E 12</u>	<u>4.98230896E 10</u>	<u>1.00048358E 09</u>	<u>-7.61540000E-09</u>
<u>1.28000000E 09</u>	<u>1.63252540E-09</u>	<u>1.87228178E 05</u>	<u>3.33006268E-22</u>
<u>5.57089365E 09</u>	<u>1.80495008E-11</u>	<u>3.17536800E 00</u>	<u>9.04471220E 01</u>
<u>2.61979789E 06</u>	<u>6.31724666E 01</u>	<u>9.97887023E 09</u>	<u>1.48940000E-04</u>
<u>2.59161459E 12</u>	<u>5.42016849E 10</u>	<u>1.02563647E 09</u>	<u>-7.61540000E-09</u>
<u>1.30000000E 09</u>	<u>1.62699891E-09</u>	<u>1.90206978E 05</u>	<u>3.11012032E-22</u>
<u>5.94466518E 09</u>	<u>1.83723454E-11</u>	<u>3.02306000E 00</u>	<u>8.85569522E 01</u>
<u>2.70627710E 06</u>	<u>6.19726282E 01</u>	<u>1.04462611E 10</u>	<u>1.48940000E-04</u>
<u>2.64179027E 12</u>	<u>5.90727800E 10</u>	<u>1.05123755E 09</u>	<u>-7.61540000E-09</u>
<u>1.32000000E 09</u>	<u>1.62184933E-09</u>	<u>1.93185778E 05</u>	<u>2.89868243E-22</u>
<u>6.35809768E 09</u>	<u>1.87009682E-11</u>	<u>2.87075200E 00</u>	<u>8.67254204E 01</u>
<u>2.79878122E 06</u>	<u>6.08239265E 01</u>	<u>1.09313168E 10</u>	<u>1.48940000E-04</u>
<u>2.69168230E 12</u>	<u>6.45154088E 10</u>	<u>1.07729892E 09</u>	<u>-7.61540000E-09</u>
<u>1.34000000E 09</u>	<u>1.61706227E-09</u>	<u>1.96164578E 05</u>	<u>2.69523199E-22</u>
<u>6.81785747E 09</u>	<u>1.90354310E-11</u>	<u>2.71844400E 00</u>	<u>8.49501262E 01</u>
<u>2.89820641E 06</u>	<u>5.97235002E 01</u>	<u>1.14346283E 10</u>	<u>1.48940000E-04</u>
<u>2.74127748E 12</u>	<u>7.06263174E 10</u>	<u>1.10383309E 09</u>	<u>-7.61540000E-09</u>
<u>1.36000000E 09</u>	<u>1.61262419E-09</u>	<u>1.99143378E 05</u>	<u>2.49928957E-22</u>
<u>7.33219355E 09</u>	<u>1.93757975E-11</u>	<u>2.56613600E 00</u>	<u>8.32287903E 01</u>
<u>3.00553863E 06</u>	<u>5.86686910E 01</u>	<u>1.19568083E 10</u>	<u>1.48940000E-04</u>
<u>2.79056313E 12</u>	<u>7.75252205E 10</u>	<u>1.13085306E 09</u>	<u>-7.61540000E-09</u>
<u>1.38000000E 09</u>	<u>1.60852239E-09</u>	<u>2.02122178E 05</u>	<u>2.31041007E-22</u>
<u>7.91143691E 09</u>	<u>1.97221336E-11</u>	<u>2.41382800E 00</u>	<u>8.15592482E 01</u>
<u>3.12200100E 06</u>	<u>5.76570261E 01</u>	<u>1.24984920E 10</u>	<u>1.48940000E-04</u>
<u>2.83952707E 12</u>	<u>8.53620483E 10</u>	<u>1.15837228E 09</u>	<u>-7.61540000E-09</u>
<u>1.40000000E 09</u>	<u>1.60474488E-09</u>	<u>2.05100978E 05</u>	<u>2.12817976E-22</u>
<u>8.56870160E 09</u>	<u>2.00745068E-11</u>	<u>2.26152000E 00</u>	<u>7.99394425E 01</u>
<u>3.24909839E 06</u>	<u>5.66862028E 01</u>	<u>1.30603383E 10</u>	<u>1.48940000E-04</u>
<u>2.88815758E 12</u>	<u>9.43271203E 10</u>	<u>1.18640473E 09</u>	<u>-7.61540000E-09</u>
<u>1.42000000E 09</u>	<u>1.60128042E-09</u>	<u>2.08079778E 05</u>	<u>1.05221370E-22</u>
<u>9.32088957E 09</u>	<u>2.04329870E-11</u>	<u>2.10921200E 00</u>	<u>7.83674171E 01</u>
<u>3.38871712E 06</u>	<u>5.57540749E 01</u>	<u>1.36430310E 10</u>	<u>1.48940000E-04</u>
<u>2.93644342E 12</u>	<u>1.04665729E 11</u>	<u>1.21496489E 09</u>	<u>-7.61540000E-09</u>
<u>1.44000000E 09</u>	<u>1.59811836E-09</u>	<u>2.11058578E 05</u>	<u>1.78215331E-22</u>

1.01901648E 10	2.07976456E-11	1.95690400E 0n	7.68413111E 01
3.54320237E 06	5.48586391E 01	1.42472800E 1n	1.48940000E-04
2.98437382E 12	1.16699532E 11	1.24406781E 0o	-7.61540000E-09
1.46000000E 09	1.59524869E-09	2.14037378E 05	1.61766419E-22
1.12061738E 10	2.11685560E-11	1.80459600E 0n	7.53593534E 01
3.71564343E 06	5.39980246E 01	1.48738221E 1n	1.48940000E-04
3.03193843E 12	1.30858778E 11	1.27372911E 09	-7.61540000E-09
1.48000000E 09	1.59266197E-09	2.17016178E 05	1.45843425E-22
1.24094943E 10	2.15457933E-11	1.65228800E 0n	7.39198574E 01
3.91005076E 06	5.31704820E 01	1.55234230E 1n	1.48940000E-04
3.07912737E 12	1.47732360E 11	1.30396501E 09	-7.61540000E-09
1.50000000E 09	1.59034927E-09	2.19994978E 05	1.30417185E-22
1.38571851E 10	2.19294346E-11	1.49998000E 0n	7.25212162E 01
4.13183399E 06	5.23743738E 01	1.61968781E 1n	1.48940000E-04
3.12593114E 12	1.68148351E 11	1.33479238E 09	-7.61540000E-09

END OF PROBLEM

INPUT CONSTANTS

MINIMUM

PLANET RADIUS= 6.04000000E 08 SURFACE GRAVITY= 8.80000000E 02
 MOLECULAR MASS= 2.96000000E 01

INITIAL CONDITIONS

HEIGHT= 0 PRESSURE= 1.00000000E 07
 TEMPERATURE= 8.00000000E 02

HEIGHT	PRESSURE	TEMPERATURE	DENSITY
PRESSURE SCALE HEIGHT	COLUMNAR MASS	MOLECULAR MASS	GRAVITY
SPEED OF SOUND	NUMBER DENSITY	DENSITY SCALE HEIGHT	TL
MEAN FREE PATH	GEOMETRIC PRESS.	POTENTIAL DENSITY	XML
	SCALE HEIGHT	SCALE HEIGHT	
1.91516969E 06	0 1.00000000E 07 1.13636364E 04	6.00000000E 02 2.96000000E 01	5.93348800E-03 8.80000000E 02

<u>4.85745721E 04</u>	<u>1.20750197E 20</u>	<u>2.37823283E 06</u>	<u>-6.10000000E-05</u>	<u>0</u>
<u>1.35584612E-06</u>	<u>1.91516969E 06</u>	<u>2.37823283E 06</u>		
<u>1.00000000E 05</u>	<u>9.48871465E 06</u>	<u>5.93900000E 02</u>	<u>5.68794490E-03</u>	
<u>1.89569879E 06</u>	<u>1.07862010E 04</u>	<u>2.96000000E 01</u>	<u>8.79708682E 02</u>	
<u>4.83270205E 04</u>	<u>1.15753241E 20</u>	<u>2.35483368E 06</u>	<u>-6.10000000E-05</u>	
<u>1.41437670E-06</u>	<u>1.89632656E 06</u>	<u>2.35405413E 06</u>		<u>0</u>
<u>2.00000000E 05</u>	<u>8.99869341E 06</u>	<u>5.87800000E 02</u>	<u>5.45018436E-03</u>	
<u>1.87622790E 06</u>	<u>1.02325611E 04</u>	<u>2.96000000E 01</u>	<u>8.79417508E 02</u>	
<u>4.80781944E 04</u>	<u>1.10914665E 20</u>	<u>2.33141865E 06</u>	<u>-6.10000000E-05</u>	
<u>1.47607790E-06</u>	<u>1.87747064E 06</u>	<u>2.32987543E 06</u>		<u>0</u>
<u>3.00000000E 05</u>	<u>8.52925890E 06</u>	<u>5.81700000E 02</u>	<u>5.22003668E-03</u>	
<u>1.85675701E 06</u>	<u>9.70197020E 03</u>	<u>2.96000000E 01</u>	<u>8.79126479E 02</u>	
<u>4.78280737E 04</u>	<u>1.06231015E 20</u>	<u>2.30798772E 06</u>	<u>-6.10000000E-05</u>	
<u>1.54115713E-06</u>	<u>1.85860193E 06</u>	<u>2.30569673E 06</u>		<u>0</u>
<u>4.00000000E 05</u>	<u>8.07974858E 06</u>	<u>5.75600000E 02</u>	<u>4.99733404E-03</u>	
<u>1.83728612E 06</u>	<u>9.19369747E 03</u>	<u>2.96000000E 01</u>	<u>8.78835594E 02</u>	
<u>4.75766382E 04</u>	<u>1.01698877E 20</u>	<u>2.28454090E 06</u>	<u>-6.10000000E-05</u>	
<u>1.60983769E-06</u>	<u>1.83972042E 06</u>	<u>2.28151803E 06</u>		<u>0</u>
<u>5.00000000E 05</u>	<u>7.64951458E 06</u>	<u>5.69500000E 02</u>	<u>4.78191077E-03</u>	
<u>1.81781523E 06</u>	<u>8.70702794E 03</u>	<u>2.96000000E 01</u>	<u>8.78544853E 02</u>	
<u>4.73238667E 04</u>	<u>9.73148788E 19</u>	<u>2.26107819E 06</u>	<u>-6.10000000E-05</u>	
<u>1.68236027E-06</u>	<u>1.82082610E 06</u>	<u>2.25733933E 06</u>		<u>0</u>
<u>6.00000000E 05</u>	<u>7.23792356E 06</u>	<u>5.63400000E 02</u>	<u>4.57360305E-03</u>	
<u>1.79834434E 06</u>	<u>8.24126214E 03</u>	<u>2.96000000E 01</u>	<u>8.78254257E 02</u>	
<u>4.70697379E 04</u>	<u>9.30756863E 19</u>	<u>2.23759957E 06</u>	<u>-6.10000000E-05</u>	
<u>1.75898446E-06</u>	<u>1.80191898E 06</u>	<u>2.23316063E 06</u>		<u>0</u>
<u>7.00000000E 05</u>	<u>6.84435647E 06</u>	<u>5.57300000E 02</u>	<u>4.37224910E-03</u>	
<u>1.77887344E 06</u>	<u>7.79571599E 03</u>	<u>2.96000000E 01</u>	<u>8.77963805E 02</u>	
<u>4.68142295E 04</u>	<u>8.89780073E 19</u>	<u>2.21410505E 06</u>	<u>-6.10000000E-05</u>	
<u>1.83999048E-06</u>	<u>1.782999905E 06</u>	<u>2.20898192E 06</u>		<u>0</u>
<u>8.00000000E 05</u>	<u>6.46820843E 06</u>	<u>5.51200000E 02</u>	<u>4.17768910E-03</u>	
<u>1.75940255E 06</u>	<u>7.36972058E 03</u>	<u>2.96000000E 01</u>	<u>8.77673497E 02</u>	
<u>4.65573189E 04</u>	<u>8.50185894E 19</u>	<u>2.19059462E 06</u>	<u>-6.10000000E-05</u>	
<u>1.92568105E-06</u>	<u>1.76406631E 06</u>	<u>2.18480322E 06</u>		<u>0</u>
<u>9.00000000E 05</u>	<u>6.10888854E 06</u>	<u>5.45100000E 02</u>	<u>3.98976520E-03</u>	
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<u>4.62989828E 04</u>	<u>8.11942205E 19</u>	<u>2.16706827E 06</u>	<u>-6.10000000E-05</u>	
<u>2.01638350E-06</u>	<u>1.74512075E 06</u>	<u>2.16062452E 06</u>		<u>0</u>

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<u>7.10738623E 05</u>	<u>5.95250287E 00</u>	<u>2.96000000E 01</u>	<u>8.57143834E 02</u>
<u>2.95910457E 04</u>	<u>1.66011628E 17</u>	<u>7.43133192E 05</u>	<u>-5.66700000E-06</u>
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4.34817501E 12	1.00698455E 10	5.58198472E 08	-7.61540000E-09
8.50000000E 08	6.28929390E-10	1.23183978E 05	3.96073982E-22
1.80444190E 09	4.14165723E-12	6.44999000E 00	1.51854525E 02
1.49099712E 06	3.69902071E 01	3.28651172E 00	1.48940000E-04
4.42600080E 12	1.04567768E 10	5.67126903E 08	-7.61540000E-09
8.60000000E 08	6.25515049E-10	1.24673378E 05	3.84622360E-22
1.84807913E 09	4.17602766E-12	6.37383600E 00	1.49787094E 02
1.50891798E 06	3.63498927E 01	3.38471899E 00	1.48940000E-04
4.50396614E 12	1.08574750E 10	5.76121844E 08	-7.61540000E-09
8.70000000E 08	6.22199448E-10	1.26162778E 05	3.73549977E-22
1.89277171E 09	4.21083321E-12	6.29768200E 00	1.47761599E 02
1.52705427E 06	3.57303669E 01	3.48508651E 00	1.48940000E-04
4.58206003E 12	1.12724762E 10	5.85184041E 08	-7.61540000E-09
8.80000000E 08	6.18979340E-10	1.27652178E 05	3.62839527E-22
1.93855840E 09	4.24607251E-12	6.22152800E 00	1.45776912E 02
1.54541384E 06	3.51307177E 01	3.58765002E 00	1.48940000E-04
4.66027161E 12	1.17023427E 10	5.94314252E 08	-7.61540000E-09
8.90000000E 08	6.15851622E-10	1.29141578E 05	3.52474682E-22
1.98547988E 09	4.28174437E-12	6.14537400E 00	1.43831945E 02
1.56400486E 06	3.45500833E 01	3.69244576E 00	1.48940000E-04
4.73859020E 12	1.21476650E 10	6.03513246E 08	-7.61540000E-09
9.00000000F 08	6.12813332E-10	1.30630978E 05	3.42440021E-22
2.03357886E 09	4.31784778E-12	6.06922000E 00	1.41925645E 02
1.58283579E 06	3.39876490E 01	3.79951055E 00	1.48940000E-04
4.81700532E 12	1.26090630E 10	6.12781802E 08	-7.61540000E-09
9.10000000E 08	6.09861639E-10	1.32120378E 05	3.32720973E-22
2.08290023E 09	4.35438191E-12	5.99306600E 00	1.40056993E 02
1.60191544E 06	3.34426441E 01	3.90888176E 00	1.48940000E-04
4.89550664E 12	1.30871880E 10	6.22120712E 08	-7.61540000E-09

9.2000000E 08	6.06993836E-10	1.33609778E 05	3.23303761E-22
2.13349118E 09	4.39134608E-12	5.91691200E 00	1.38225005E 02
1.62125295E 06	3.29143389E 01	4.02059733E 09	1.48940000E-04
4.97408399E 12	1.35827250E 10	6.31530781E 08	-7.61540000E-09
9.30000000E 08	6.04207334E-10	1.35099178E 05	3.14175349E-22
2.18540139E 09	4.42873977E-12	5.84075800E 00	1.36428728E 02
1.64085786E 06	3.24020422E 01	4.13469578E 09	1.48940000E-04
5.05272739E 12	1.40963948E 10	6.41012825E 08	-7.61540000E-09
9.40000000E 08	6.01499656E-10	1.36588578E 05	3.05323397E-22
2.23868312E 09	4.46656261E-12	5.76460400E 00	1.34667239E 02
1.66074008E 06	3.19050991E 01	4.25121622E 09	1.48940000E-04
5.13142698E 12	1.46289562E 10	6.50567673E 08	-7.61540000E-09
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2.29339147E 09	4.50481435E-12	5.68845000E 00	1.32939647E 02
1.68090996E 06	3.14228880E 01	4.37019837E 09	1.48940000E-04
5.21017312E 12	1.51812085E 10	6.60196167E 08	-7.61540000E-09
9.60000000E 08	5.96311378E-10	1.39567378E 05	2.88402720E-22
2.34958452E 09	4.54349489E-12	5.61229600E 00	1.31245086E 02
1.70137830E 06	3.09548194E 01	4.49168254E 09	1.48940000E-04
5.28895627E 12	1.57539946E 10	6.69899161E 08	-7.61540000E-09
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2.40732352E 09	4.58260427E-12	5.53614200E 00	1.29582720E 02
1.72215637E 06	3.05003334E 01	4.61570971E 09	1.48940000E-04
5.36776709E 12	1.63482036E 10	6.79677524E 08	-7.61540000E-09
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2.46667316E 09	4.62214263E-12	5.45998800E 00	1.27951740E 02
1.74325596E 06	3.00588982E 01	4.74232146E 09	1.48940000E-04
5.44659638E 12	1.69647743E 10	6.89532137E 08	-7.61540000E-09
9.90000000E 08	5.89063960E-10	1.44035578E 05	2.64821927E-22
2.52770181E 09	4.66211023E-12	5.38383400E 00	1.26351358E 02
1.76468939E 06	2.96300082E 01	4.87156003E 09	1.48940000E-04
5.52543507E 12	1.76046987E 10	6.99463895E 08	-7.61540000E-09
1.00000000E 09	5.86782717E-10	1.45524978E 05	2.57403300E-22
2.59048171E 09	4.70250745E-12	5.30768000E 00	1.24780816E 02
1.78646956E 06	2.92131823E 01	5.00346834E 09	1.48940000E-04
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1.02000000E 09	5.82442977E-10	1.48503778E 05	2.43189896E-22
2.72160575E 09	4.78485646E-12	5.15537200E 00	1.21726322E 02
1.83112487E 06	2.84154808E 01	5.27546921E 09	1.48940000E-04

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1.04000000E 09	5.78344881E-10	1.51482578E 05	2.29736434E-22
2.86071339E 09	4.86893496E-12	5.00306400E 00	1.18782626E 02
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5.91881744E 12	2.11935690E 10	7.50312206E 08	-7.61540000E-09
1.06000000E 09	5.74475659E-10	1.54461378E 05	2.16985526E-22
3.00855666E 09	4.95474978E-12	4.85075600E 00	1.15944434E 02
1.92523812E 06	2.69457841E 01	5.85347261E 09	1.48940000E-04
6.07585535E 12	2.28344714E 10	7.71224511E 08	-7.61540000E-09
1.08000000E 09	5.70823499E-10	1.57440178E 05	2.04885066E-22
3.16598511E 09	5.04230914E-12	4.69844800E 00	1.13206764E 02
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1.10000000E 09	5.67377456E-10	1.60418978E 05	1.93387654E-22
3.33396211E 09	5.13162258E-12	4.54614000E 00	1.10564923E 02
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6.38914615E 12	2.65354198E 10	8.14075571E 08	-7.61540000E-09
1.12000000E 09	5.64127377E-10	1.63397778E 05	1.82450092E-22
3.51358463E 09	5.22270085E-12	4.39383200E 00	1.08014492E 02
2.08056153E 06	2.50132502E 01	6.81119259E 09	1.48940000E-04
6.54527839E 12	2.86253671E 10	8.36031257E 08	-7.61540000E-09
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3.70610721E 09	5.31555584E-12	4.24152400E 00	1.05551300E 02
2.13680230E 06	2.44320092E 01	7.15623474E 09	1.48940000E-04
6.70099151E 12	3.08984763E 10	8.58352139E 08	-7.61540000E-09
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3.91297129E 09	5.41020054E-12	4.08921600E 00	1.03171415E 02
2.19562762E 06	2.38788197E 01	7.51488883E 09	1.48940000E-04
6.85623026E 12	3.33756664E 10	8.81047404E 08	-7.61540000E-09
1.18000000E 09	5.55461852E-10	1.72334178E 05	1.52618681E-22
4.13584135E 09	5.50664892E-12	3.93690800E 00	1.00871121E 02
2.25728965E 06	2.33518837E 01	7.88760305E 09	1.48940000E-04
7.01094132E 12	3.60810937E 10	9.04126552E 08	-7.61540000E-09
1.20000000E 09	5.52907634E-10	1.75312978E 05	1.43558236E-22
4.37664985E 09	5.60491594E-12	3.78460000E 00	9.86469093E 01
2.32207507E 06	2.28495482E 01	8.27484086E 09	1.48940000E-04
7.16507324E 12	3.90428032E 10	9.27599404E 08	-7.61540000E-09

1.22000000E 09	5.50508283E-10	1.78291778E 05	1.34890978E-22
4.63765333E 09	5.70501744E-12	3.63229200E 00	9.64954601E 01
2.39031147E 06	2.23702913E 01	8.67708167E 09	1.48940000E-04
7.31857641E 12	4.22935434E 10	9.51476123E 08	-7.61540000E-09
1.24000000E 09	5.48257158E-10	1.81270578E 05	1.26591296E-22
4.92150343E 09	5.80697016E-12	3.47998400E 00	9.44136344E 01
2.46237532E 06	2.19127099E 01	9.09482153E 09	1.48940000E-04
7.47140299E 12	4.58717965E 10	9.75767222E 08	-7.61540000E-09
1.26000000E 09	5.46148047E-10	1.84249378E 05	1.18635591E-22
5.23133722E 09	5.91079166E-12	3.32767600E 00	9.23984601E 01
2.53870192E 06	2.14755083E 01	9.52857387E 09	1.48940000E-04
7.62350691E 12	4.98230896E 10	1.00048358E 09	-7.61540000E-09
1.28000000E 09	5.44175134E-10	1.87228178E 05	1.11002089E-22
5.57089365E 09	6.01650027E-12	3.17536800E 00	9.04471220E 01
2.61979789E 06	2.10574889E 01	9.97887023E 00	1.48940000E-04
7.77484377E 12	5.42016849E 10	1.02563647E 09	-7.61540000E-09
1.30000000E 09	5.42332971E-10	1.90206978E 05	1.03670677E-22
5.94466518E 09	6.12411513E-12	3.02306000E 00	8.85569522E 01
2.70625710E 06	2.06575427E 01	1.04462611E 10	1.48940000E-04
7.92537081E 12	5.90727800E 10	1.05123755E 09	-7.61540000E-09
1.32000000E 09	5.40616444E-10	1.93185778E 05	9.66227477E-23
6.35809768E 09	6.23365607E-12	2.87075200E 00	8.67254204E 01
2.79878122E 06	2.02746422E 01	1.09313168E 10	1.48940000E-04
8.07504689E 12	6.45154088E 10	1.07729892E 09	-7.61540000E-09
1.34000000E 09	5.39020755E-10	1.96164578E 05	8.98410664E-23
8.81785747E 09	6.34514367E-12	2.71844400E 00	8.49501262E 01
2.89820641E 06	1.99078334E 01	1.14346283E 10	1.48940000E-04
8.22383244E 12	7.06263174E 10	1.10383309E 09	-7.61540000E-09
1.36000000E 09	5.37541397E-10	1.99143378E 05	8.33096525E-23
7.33219355E 09	6.45859918E-12	2.56613600E 00	8.32287903E 01
3.00553863E 06	1.95562303E 01	1.19568083E 10	1.48940000E-04
8.37168940E 12	7.75252205E 10	1.13085306E 09	-7.61540000E-09
1.38000000E 09	5.36174129E-10	2.02122178E 05	7.70136689E-23
7.91143691E 09	6.57404452E-12	2.41382800E 00	8.15592482E 01
3.12200100E 06	1.92190087E 01	1.24984920E 10	1.48940000E-04
8.51858121E 12	8.53620483E 10	1.15837228E 09	-7.61540000E-09
1.40000000E 09	5.34914962E-10	2.05100978E 05	7.09393254E-23
8.56870160E 09	6.69150228E-12	2.26152000E 00	7.99394425E 01

3.24909839E 06	1.88954009E 01	1.30603383E 10	1.48940000E-04
8.66447273E 12	9.43271203E 10	1.18640473E 00	-7.61540000E-09
1.42000000E 09	5.33760138E-10	2.08079778E 05	6.50737901E-23
9.32088957E 09	6.81099567E-12	2.10921200E 00	7.83674171E 01
3.38870712E 06	1.85846916E 01	1.36430310E 10	1.48940000E-04
8.80933026E 12	1.04665729E 11	1.21496489E 00	-7.61540000E-09
1.44000000E 09	5.32706119E-10	2.11058578E 05	5.94051102E-23
1.01901648E 10	6.93254853E-12	1.95690400E 00	7.68413111E 01
3.54320237E 06	1.82862130E 01	1.42472800E 10	1.48940000E-04
8.95312145E 12	1.16699532E 11	1.24406781E 00	-7.61540000E-09
1.46000000E 09	5.31749564E-10	2.14037378E 05	5.39221398E-23
1.12061738E 10	7.05618533E-12	1.80459600E 00	7.53593534E 01
3.71564343E 06	1.79993415E 01	1.48738221E 10	1.48940000E-04
9.09581530E 12	1.30858778E 11	1.27372911E 00	-7.61540000E-09
1.48000000E 09	5.30887323E-10	2.17016178E 05	4.86144751E-23
1.24094943E 10	7.18193111E-12	1.65228800E 00	7.39198574E 01
3.91005076E 06	1.77234940E 01	1.55234230E 10	1.48940000E-04
9.23738210E 12	1.47732360E 11	1.30396501E 00	-7.61540000E-09
1.50000000E 09	5.30116422E-10	2.19994978E 05	4.34723949E-23
1.38571851E 10	7.30981153E-12	1.49998000E 00	7.25212162E 01
4.13183399E 06	1.74581246E 01	1.61968781E 10	1.48940000E-04
9.37779343E 12	1.68148351E 11	1.33479238E 00	-7.61540000E-09

END OF PROBLEM

INPUT CONSTANTS

MAXIMUM

PLANET RADIUS= 6.04000000E 08 SURFACE GRAVITY= 8.80000000E 02
 MOLECULAR MASS= 2.96000000E 01

INITIAL CONDITIONS

HEIGHT= 0 PRESSURE= 1.00000000E 08
 TEMPERATURE= 8.00000000E 02

HEIGHT	PRESSURE	TEMPERATURE	DENSITY
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PRESSURE SCALE HEIGHT	COLUMNAR MASS	MOLECULAR MASS	GRAVITY
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SPEED OF SOUND	NUMBER DENSITY	DENSITY SCALE HEIGHT	TL
MEAN FREE PATH	GEOMETRIC PRESS.	POTENTIAL DENSITY	XML
	SCALE HEIGHT	SCALE HEIGHT	
0	1.00000000E 08	8.00000000E 02	4.45011600E-02
2.55355958E 06	1.13636364E 05	2.96000000E 01	8.80000000E 02
5.60890845E 04	9.05626476E 20	3.29844993E 06	-7.07500000E-05
1.80779483E-07	2.55355958E 06	3.29844993E 06	0
1.00000000E 05	9.61428371E 07	7.92925000E 02	4.31664309E-02
2.53097654E 06	1.09289404E 05	2.96000000E 01	8.79708682E 02
5.58405148E 04	8.78463903E 20	3.27036190E 06	-7.07500000E-05
1.86369281E-07	2.53181468E 06	3.26927927E 06	0
2.00000000E 05	9.24018690E 07	7.85850000E 02	4.18603078E-02
2.50839350E 06	1.05071673E 05	2.96000000E 01	8.79417508E 02
5.55908337E 04	8.51883479E 20	3.24225472E 06	-7.07500000E-05
1.92184366E-07	2.51005496E 06	3.24010860E 06	0
3.00000000E 05	8.87745945E 07	7.78775000E 02	4.05824269E-02
2.48581045E 06	1.00980458E 05	2.96000000E 01	8.79126479E 02
5.53400260E 04	8.25877802E 20	3.21412840E 06	-7.07500000E-05
1.98235969E-07	2.48828042E 06	3.21093793E 06	0
4.00000000E 05	8.52585441E 07	7.71700000E 02	3.93324257E-02
2.46322741E 06	9.70130758E 04	2.96000000E 01	8.78835594E 02
5.50880765E 04	8.00439495E 20	3.18598292E 06	-7.07500000E-05
2.04535992E-07	2.46649105E 06	3.18176727E 06	0
5.00000000E 05	8.18512803E 07	7.64625000E 02	3.81099433E-02
2.44064437E 06	9.31668770E 04	2.96000000E 01	8.78544853E 02
5.48349693E 04	7.75561213E 20	3.15781829E 06	-7.07500000E-05
2.11097053E-07	2.44468684E 06	3.15259660E 06	0
6.00000000E 05	7.85503974E 07	7.57550000E 02	3.69146201E-02
2.41806133E 06	8.94392446E 04	2.96000000E 01	8.78254257E 02
5.45806885E 04	7.51235637E 20	3.12963450E 06	-7.07500000E-05
2.17932534E-07	2.42286781E 06	3.12342593E 06	0
7.00000000E 05	7.53535210E 07	7.50475000E 02	3.57460979E-02
2.39547028E 06	8.58275940E 04	2.96000000E 01	8.77963805E 02
5.43252174E 04	7.27455478E 20	3.10143154E 06	-7.07500000E-05
2.25056641E-07	2.40103393E 06	3.09425527E 06	0

8.0000000E 05	7.22583085E 07	7.43400000E 02	3.46040199E-02
2.37289524E 06	8.23293727E 04	2.96000000E 01	8.77673497E 02
5.40685393E 04	7.04213476E 20	3.07320941E 06	-7.07500000E-05
2.32484455E-07	2.37918522E 06	3.06508460E 06	0
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9.00000000E 05	6.92624482E 07	7.36325000E 02	3.34880309E-02
2.3503220E 06	7.89420606E 04	2.96000000E 01	8.77383333E 02
5.38106368E 04	6.81502401E 20	3.04496810E 06	-7.07500000E-05
2.40232002E-07	2.35732166E 06	3.03591394E 06	0
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1.00000000E 06	6.63636601E 07	7.29250000E 02	3.23977770E-02
2.32772916E 06	7.56631696E 04	2.96000000E 01	8.77093313E 02
5.35514922E 04	6.59315051E 20	3.01670761E 06	-7.07500000E-05
2.48316318E-07	2.33544325E 06	3.00674327E 06	0
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1.10000000E 06	6.35596949E 07	7.22175000E 02	3.13329058E-02
2.30514611E 06	7.24902438E 04	2.96000000E 01	8.76803437E 02
5.32910876E 04	6.37644255E 20	2.98842794E 06	-7.07500000E-05
2.56755526E-07	2.31354999E 06	2.97757260E 06	0
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1.20000000E 06	6.08483344E 07	7.15100000E 02	3.02930663E-02
2.28256307E 06	6.94208592E 04	2.96000000E 01	8.76513704E 02
5.30294041E 04	6.16482872E 20	2.96012908E 06	-7.07500000E-05
2.65568913E-07	2.29164187E 06	2.94840194E 06	0
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1.30000000E 06	5.82273912E 07	7.08025000E 02	2.92779092E-02
2.25998003E 06	6.64526235E 04	2.96000000E 01	8.76224115E 02
5.27664230E 04	5.95823787E 20	2.93181102E 06	-7.07500000E-05
2.74777023E-07	2.26971889E 06	2.91923127E 06	0
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1.40000000E 06	5.56947086E 07	7.00950000E 02	2.82870863E-02
2.23739699E 06	6.35831764E 04	2.96000000E 01	8.75934670E 02
5.25021246E 04	5.75659921E 20	2.90347376E 06	-7.07500000E-05
2.84401745E-07	2.24778105E 06	2.89006060E 06	0
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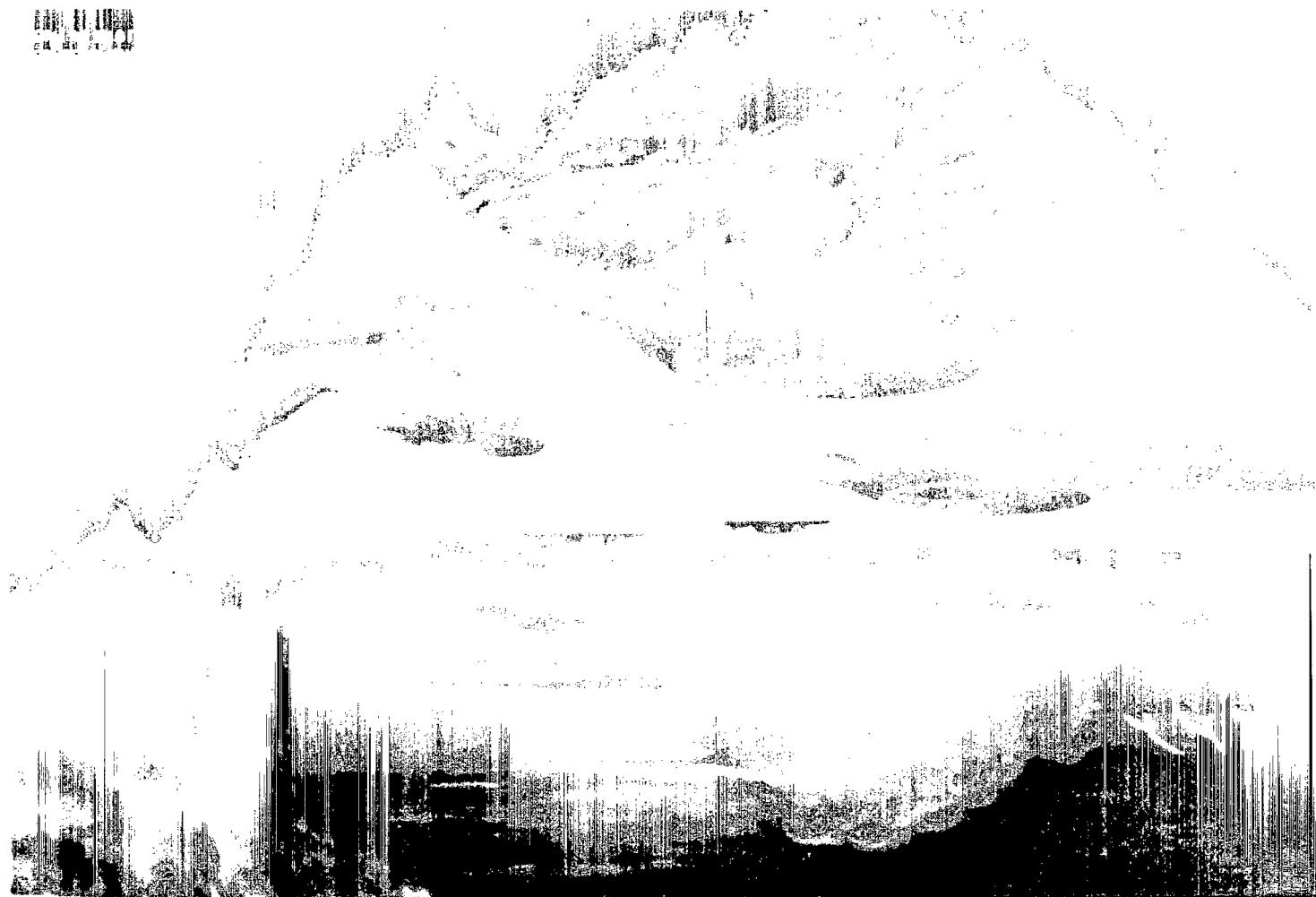
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Feature IV

The authors are grateful to Malcolm Smith, MSFC Management Services Office, and John Rogers, Brown Engineering, for their aid in the formulation of this conception. Art work by Ray Venderwall, MSFC Management Services Office.



Artist's CONCEPTION OF THE CRYSTALLAN SURFACE, CREEKHOUSE MODEL VERSION

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by Robert B. Owen, C. L. Hasseltine, William T. Roberts,
George S. West, and Jeanette A. Scissum

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